

Resurrection of *Perilimnastes* (Sonerileae, Melastomataceae) with description of a new species *P. nana*

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Abstract

Recent research has indicated that the *Phyllagathis* (raphides) clade (Sonerileae, Melastomataceae) is only distantly related to the type of *Phyllagathis* and should be separated as a distinct genus. Phylogeny of this clade is here reconstructed with expanded taxon sampling. Four strongly supported subclades have been identified. The possible affinities of taxa that were not sampled in the analysis are discussed, based on morphological data. *Perilimnastes* is resurrected as the generic name of the *Phyllagathis* (raphides) clade. A generic description, colour figures, map of distribution, a list of included species and a key are provided for *Perilimnastes*. Fifteen new combinations are made plus the description of a new species. As interpreted here, *Perilimnastes* consists of twenty species and two varieties.

Key words: Melastomataceae, *Perilimnastes*, *Phyllagathis*, taxonomy



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Introduction

The genus *Perilimnastes* Ridl. was initially established based on *P. fruticosa* (Ridl.) Ridl. (Ridley 1918, 1922). Nayar (1974) followed Ridley's concept of *Perilimnastes* and described a second species in the genus, namely *P. rupicola* M.P.Nayar. The two species show clear similarities in the morphology of leaves, calyx lobes, stamens, and capsules. However, subsequent authors did not recognise *Perilimnastes* (Maxwell 1982, 1989; Cellinese 2002, 2003). Both species are currently treated in a broadly defined *Phyllagathis* Blume. Previous molecular phylogenetic studies have revealed the polyphyletic nature of *Phyllagathis* (Zeng et al. 2016; Zhou et al. 2018; Zhou et al. 2019a, b, c; Liu et al. 2022; Zhou et al. 2022). The species currently treated under *Phyllagathis* were found to be nested within 17 lineages of Asian Sonerileae (Liu et al. 2022; Zhou et al. 2022). Although *P. fruticosa*, the generic type of *Perilimnastes*, was not sampled in these studies, species that are quite similar to it were identified as belonging to the *Phyllagathis* (raphides) clade. Members of this clade are often shrubs or shrublets with cuneate to rounded leaf bases, umbellate or cymose inflorescences (sometimes reduced to a single flower), isomorphic stamens, dorsally spurred connectives, crowned capsules, horned placental column and thready

placentas. Some of them (Fig. 1) are also characterised by the presence of raphide crystals in various parts of the plant. Based on these diagnostic features as well as strong resemblance between sampled and unsampled species, Zhou et al. (2022) estimated that the *Phyllagathis* (raphides) clade might contain 20 species in southernmost China, Vietnam, the Malay Peninsula and Borneo. This clade should be removed from *Phyllagathis* and treated as a distinct genus, since it is only remotely related to the type of *Phyllagathis*. As a result, *Perilimnastes* should be re-instated as the generic name (Zhou et al. 2022).

This work aims to formalize the taxonomic treatment of the *Phyllagathis* (raphides) clade. To this end, we reconstructed the phylogeny of this clade with expanded taxon sampling, using a nuclear genomic dataset assembled by mapping the genome resequencing reads to the draft genome of *Bredia hirsuta* Blume. We also discussed putative affinities based on morphological data for species that were not sampled in the phylogenetic analysis. *Perilimnastes* is resurrected as the generic name of the *Phyllagathis* (raphides) clade. A generic description, colour figures, map of distribution, a list of included species and a key are provided for *Perilimnastes*. Fifteen new combinations are made plus the description of a new species from southern China. *Perilimnastes*, as we here delimit it, now consists of twenty species and two varieties.

Methods

Phylogenetic reconstruction

For phylogenetic reconstruction of the *Phyllagathis* (raphides) clade, ingroups and outgroup were selected according to the genomic tree of Sonerileae (Zhou et al. 2022). We sampled 36 accessions from Sonerileae, including 16 species from the *Phyllagathis* (raphides) clade, as well as species of *Phyllagathis* [including the generic type *P. rotundifolia* (Jack) Blume], *Styrophyton* S.Y.Hu, *Bredia* Blume, *Fordiophyton* Stapf, *Blastus* Lour., *Kerriothyrsus* C.Hansen, *Cyphotheca* Diels, *Plagiopetalum* Rehder and *Sporoxeia* W.W.Sm. (Suppl. material 1: table S1).

For DNA extraction, library preparation, whole genome resequencing and quality control of the raw reads, methods employed in this study followed the protocols outlined in Zhou et al. (2022). The genomic single nucleotide polymorphism (SNP) dataset was assembled by mapping the genome resequencing data to the draft genome of *Bredia hirsuta*, which can be accessed at <https://doi.org/10.17632/s85vv6yyjs.1>. High-quality reads were mapped to the reference genome using BWA-MEM (Li and Durbin 2010). SNPs and short insertions/deletions (InDels) were identified using HaplotypeCaller in GATK v.4.1.8.1 (McKenna et al. 2010) under the GVCF mode for each sample separately. Next, we conducted hard filtering to minimise false positives by applying the following parameters: (1) QUAL < 30.0; (2) DP < 15.0; (3) QD < 2.0; (4) FS > 60.0; (5) MQ < 50.0; (6) SOR > 3.0; (7) MQRankSum < -12.5; (8) ReadPosRankSum < -8.0; (9) InbreedingCoeff < -0.5. VCFtools v.0.1.16 (Danecek et al. 2011) is used to exclude SNPs with a missing rate exceeding 15% and those with minor allele frequencies (MAF) below 0.05. The SNPs obtained were pruned, based on their linkage disequilibrium (LD) patterns using the `-indep-pairwise` option in PLINK (Purcell et al. 2007). Only one SNP was retained for each SNP pair with an r^2 value above 0.5 within a sliding window of 50-SNPs (advanced by 5 SNPs each).

Maximum Likelihood analysis of the genomic dataset was performed using a partitioned approach in IQ-TREE v.2.0.3 (Nguyen et al. 2015). *Phyllagathis rotundifolia* was designated as the outgroup taxon. The selection of best fitting substitution model was conducted using ModelFinder (Kalyaanamoorthy et al. 2017) based on the Bayesian Information Criterion (BIC). The genomic dataset was partitioned into bins of equal length, each containing 2,000 SNPs. TVMe+ASC+R2 was selected as the best fitting substitution model for all partitions. Node support was assessed using 1000 replicates of the UFBS and SH-aLRT test.

Morphological comparison

Morphological data were obtained through fieldwork, herbarium records, literature survey and observation of living plants in the facilities of Sun Yat-sen University. We examined specimens or their high-resolution photos of the relevant species from the following herbaria: A, BM, C, E, G, GXMI, IBSC, IBK, K, KUN, NY, P, PE, SYS and US. Species delimitation mainly followed Chen (1984a), Hansen (1992), Cellinese (2002, 2003) and Chen and Renner (2007).

Results and discussion

Phylogenetic relationships

After SNP filtering and pruning, the genomic dataset contained 2,412,522 SNPs, 1,667,363 of which were parsimony informative, with 26.46% of missing data (available at <http://doi.org/10.17632/g9yjn97kns.2>). The partitioned genomic ML tree was presented in Fig. 1. All nodes in the tree received full support (SH-aLRT test = 100%, UFBS = 100%), except for five nodes (Fig. 1).

Four well-supported lineages were identified within the *Phyllagathis* (raphides) clade, but relationships amongst them were only moderately supported (SH-aLRT test = 100%, UFBS = 92%; SH-aLRT test = 100%, UFBS = 92%). Subclade 1 contains *Perilimnastes multisepala* J.H.Dai, T.V.Do & Ying Liu from central Vietnam, *Phyllagathis setotheca* H.L.Li from southern China and a new species from Guangdong, China, namely *Perilimnastes nana* C.Y.Zou & Ying Liu. The three species are characterised by large flowers (> 20 mm in diameter), large anthers (> 8 mm long) and the presence of druses (instead of raphides). Subclade 2 consists of two species from Hainan Island, China [*Phyllagathis stenophylla* (Merr. & Chun) H.L.Li and *P. melastomatoides* (Merr. & Chun) W.C.Ko] and two from central Vietnam (*P. suberalata* C.Hansen and *P. sessilifolia* C.Hansen). Species in this subclade varied in the morphology of leaves and flowers, but they all have druses and yellow connectives that produced into a collar at the anther base. Subclade 3 comprises two species from Borneo [*Phyllagathis dispar* (Cogn.) C.Hansen and *P. elliptica* Stapf] and three newly-published species from central and southern Vietnam (*Perilimnastes setipetiola* J.H.Dai, T.V.Do & Ying Liu, *P. uniflora* J.H.Dai, T.V.Do & Ying Liu and *P. banaensis* J.H.Dai, T.V.Do & Ying Liu). These species are morphologically quite different, yet all of them have raphide crystals, somewhat elliptic leaf blade and at least some have terminal and axillary umbels with very short or no peduncles. Subclade 4 consists of five taxa mainly distributed in southern China, viz. *Phyllagathis deltoidea* C.Chen, *P. elegans* Hai L.Chen, Yan



Species without molecular data

Perilimnastes fruticosa, *Phyllagathis guillauminii* H.L.Li, *Phyllagathis brookei* M.P.Nayar and *Perilimnastes rupicola* M.P.Nayar, four putative members of the *Phyllagathis* (raphides) clade, have never been included in phylogenetic studies. Nevertheless, they can be easily referred to specific lineages within this clade, based on compelling morphological evidence. *Perilimnastes fruticosa* from the Malay Peninsula closely resembles *P. multisepala* from subclade 1 and *P. stenophylla* and *P. suberalata* from subclade 2. The four species are shrubs characterised by somewhat oblong-lanceolate, 3-veined leaf blades, few-flowered inflorescences, narrow calyx lobes and the presence of druses. Moreover, they grow in similar habitats, specifically on rocks along streams in dense forests. *Perilimnastes fruticosa* is possibly a member of subclade 1 or subclade 2.

Raphides have been found in the tissues of *P. guillauminii* (southern Vietnam), *P. brookei* (Borneo) and *P. rupicola* (Borneo). The three species can be confidently referred to subclade 3 since all Vietnamese and Bornean species with raphides were consistently recovered as members of this subclade in phylogenetic analyses (Zhou et al. 2022; this study). *Phyllagathis guillauminii* resembles *P. uniflora* from subclade 3 in 3-veined leaves with cuneate base and somewhat acuminate apex and narrow calyx lobes. The close relationships amongst *P. dispar*, *P. elliptica*, *P. brookei* and *P. rupicola* had been proposed by Cellinese (2003). Their caulescent and erect stems, small leaves, few-flowered umbels, as well as crystal type make them a distinct group that is morphologically very different from other Bornean species treated under *Phyllagathis* (Cellinese 2003).

Another species, *P. marumiaetricha* (Guillaumin) C.Hansen, was listed as a putative member of the *Phyllagathis* (raphides) clade by Zhou et al. (2022). It resembles *P. setotheca* from subclade 1 in the inflorescences with large basal bracts, petals and flowers. However, the huge leaves, distinctive hypanthial emergences and the peculiar sepals of this species readily distinguish it from members of the *Phyllagathis* (raphides) clade. As its generic affiliation remains to be further tested, no taxonomic treatment is proposed here.

Conclusion

Molecular phylogenetic data and morphological evidence support the *Phyllagathis* (raphides) clade as a distinct lineage encompassing species distributed in southernmost China, Vietnam, the Malay Peninsula and Borneo. *Perilimnastes* is, therefore, resurrected below as the generic name for this clade. For a comparison of *Perilimnastes* [the *Phyllagathis* (raphides) clade] and other lineages of Asian Sonerileae, please see table S9 in Zhou et al. (2022).

Taxonomy

***Perilimnastes* Ridl., J. Straits Branch Roy. Asiat. Soc. 79: 70. 1918, emend.**

Ying Liu

Type. *Perilimnastes fruticosa* (Ridl.) Ridl., J. Straits Branch Roy. Asiat. Soc. 79: 70, in obs. 1918; Ridley, Fl. Mal. Penins. 1: 773. 1922.

Description. Erect shrubs, erect/ascending shrublets or caulescent herbs, sometimes with raphides in many parts. Stems terete, obtusely 4-sided or ribbed, with uniseriate or multiseriate, appressed or spreading hairs, rarely glabrous. Leaves opposite, equal, subequal or unequal in a pair, petiolate, rarely sessile (in *P. sessilifolia*); leaf blades elliptic, ovate, elliptic-lanceolate, obovate, oblanceolate or suborbicular, submembranous, papery or stiffly papery, 3–7-nerved, base cuneate, acute, rounded, subcordate to broadly cordate, margin entire or inconspicuously serrulate or denticulate. Inflorescences usually terminal (rarely axillary) umbels subtended by two or more bracts, many- to few-flowered, sometimes reduced to a single flower. Flowers 4-merous; hypanthia ± campanulate, cup-shaped or funnel-shaped; calyx lobes triangular, ± attenuate to ligulate or linear; petals white, pink or purplish, obovate, ovate, oblong, or elliptic, more or less oblique, apex acute or acuminate; stamens 8, equal or subequal; anthers isomorphic, yellow, pinkish or purplish, narrowly ovate to lanceolate,

curved to ventral side, connectives ventrally inappendiculate and dorsally spurred, or basally forming a collar with two ventral auricles/lobes/ridges and a dorsal spur; ovary half inferior, ovoid, 4-celled, crown of four partly or fully connate lobes; style filiform. Old capsule cup-shaped, campanulate, quadrangular, crown persistent and enlarged, enclosing an obpyramidal space; placental column 4-horned; placentas thready. Seeds numerous, minute, cuneate. (Figs 2–4)

Distribution. Twenty species and two varieties, eight species (seven endemic) and two varieties in southernmost China (Guangdong, Guangxi, Hainan, Yunnan), eight (seven endemic) in Vietnam, one on the Malay Peninsula and four in Borneo (Fig. 5).

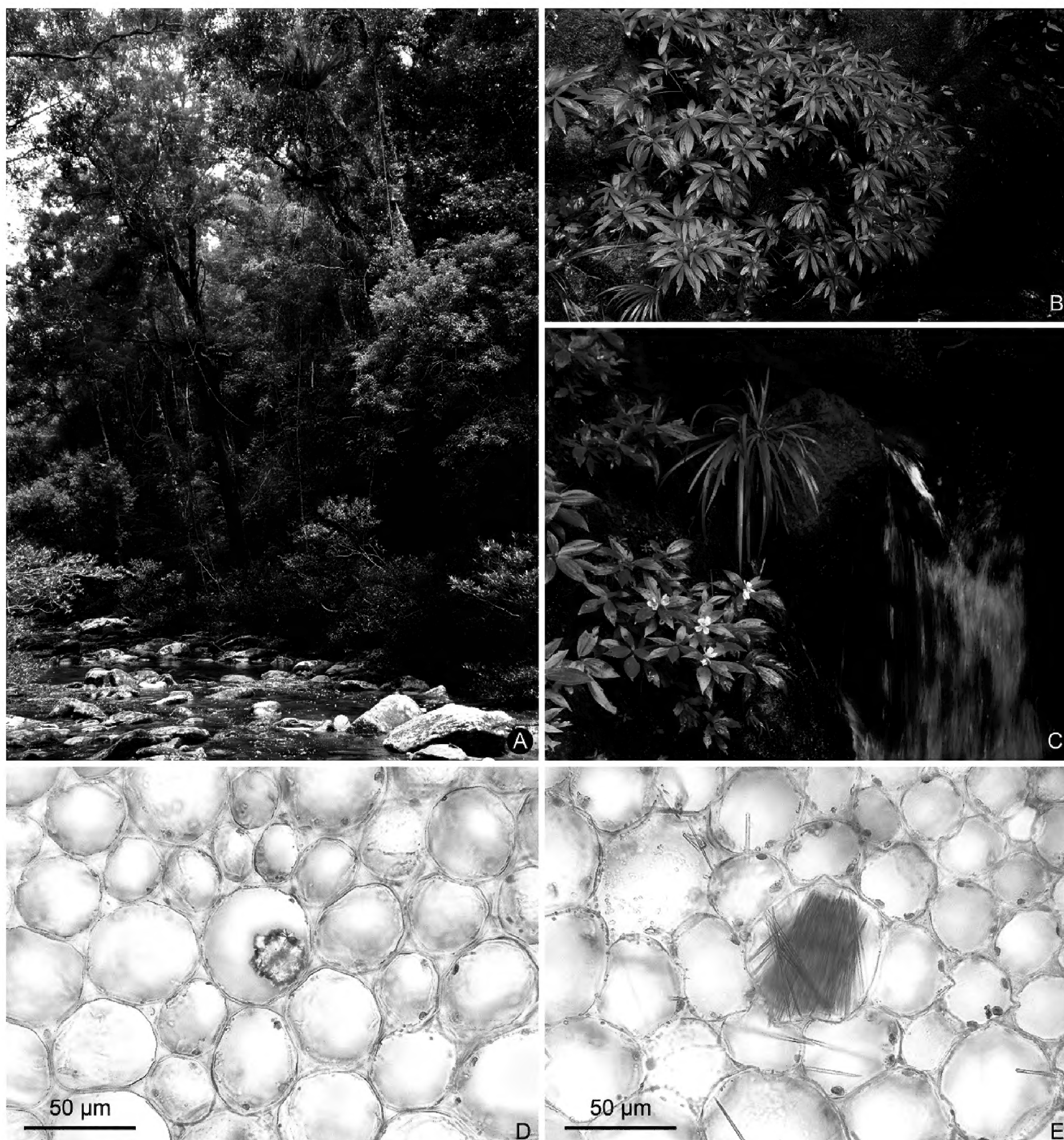


Figure 2. Habitat (A–C) and crystal type (D, E) of *Perilimnastes* A *P. stenophylla* B *P. elegans* C *P. melastomatoides* D druses of *P. multisepala* E raphides of *P. elegans*. Scale bars: 50 µm (D, E).



Figure 3. Flowering/fruiting branches of *Perilimnastes* **A** *P. deltoidea* **B** *P. elegans* **C** *P. elliptica* **D** *P. melastomatoides* **E** *P. stenophylla* **F** *P. suberalata*.

Species included in *Perilimnastes*

***Perilimnastes banaensis* J.H.Dai, T.V.Do & Ying Liu, PhytoKeys 235: 14. 2023.**

Type. VIETNAM. Đà Nẵng: Hòa Ninh, Ba Na Hills, 1,360 m elevation, in forests on damp slopes near steam, 22 Nov 2019, Jin-hong Dai and Ying Liu 813 (holotype: PE; isotypes: A, SYS, VNMN).

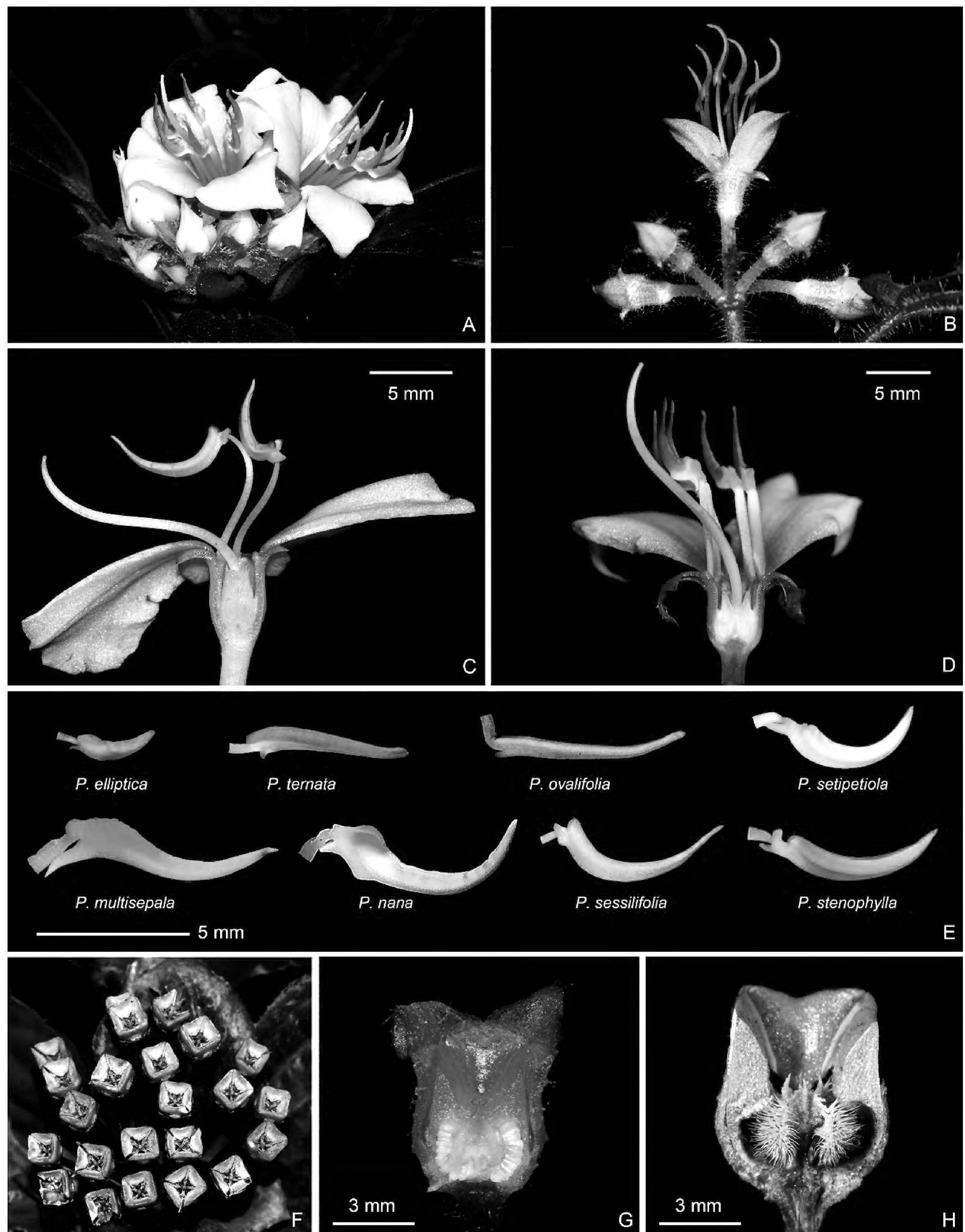


Figure 4. Inflorescence (**A**, **B**), longitudinal section of flower (**C**, **D**), anther morphology (**E**), infructescence (**F**), and longitudinal sections of young and old capsules (**G**, **H**) of *Perilimnastes* **A** *P. setotheca* **B** *P. ternata* **C** *P. sessilifolia* **D** *P. setotheca* **E** *P. elliptica*, *P. ternata*, *P. ovalifolia*, *P. setipetiola*, *P. multisepala*, *P. nana*, *P. sessilifolia* and *P. stenophylla* (from left to right and top to bottom) **F** *P. elliptica* **G** *P. ovalifolia* **H** *P. ovalifolia*. Scale bars: 5 mm (**C–E**); 3 mm (**G**, **H**).

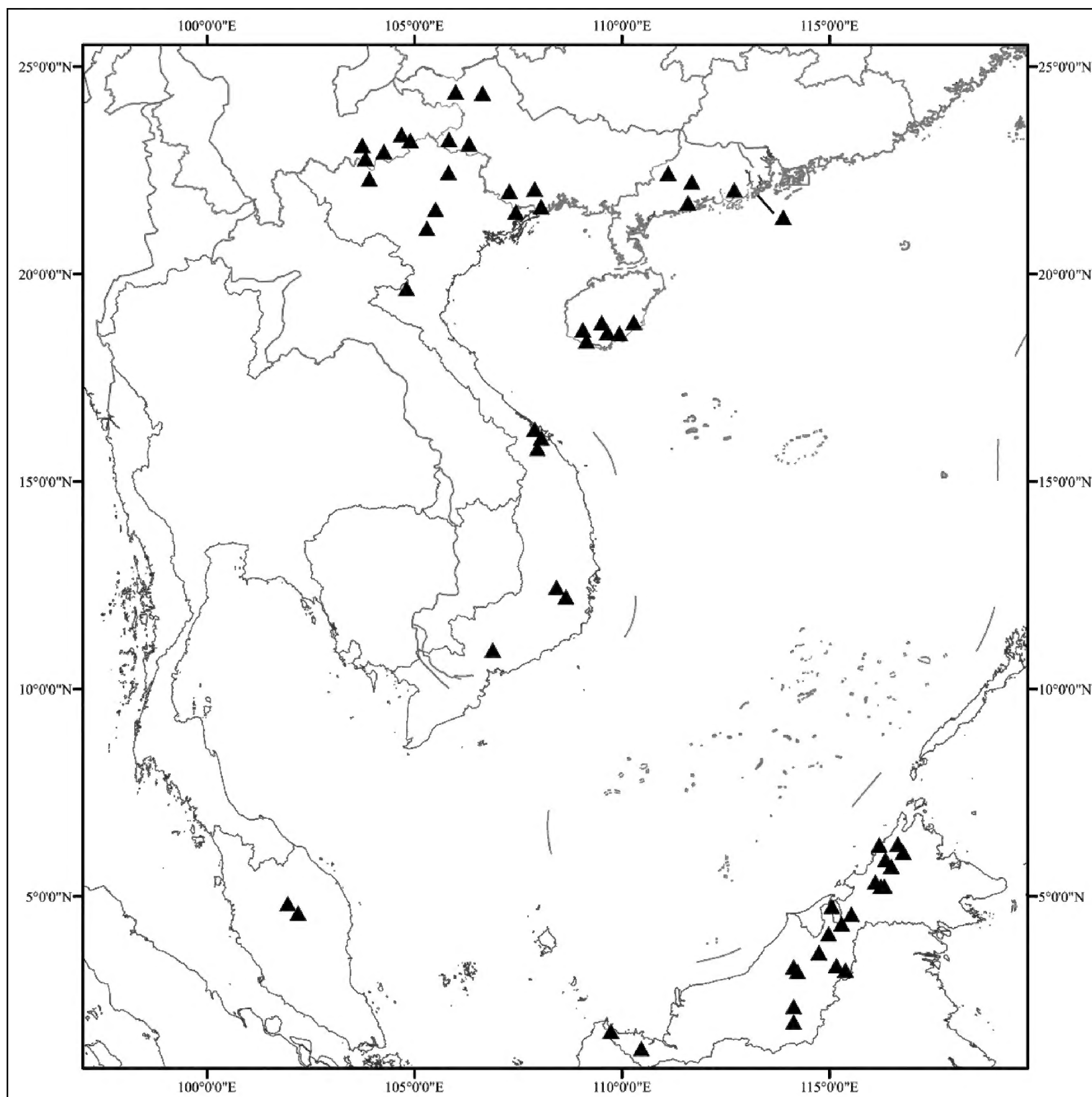


Figure 5. Distribution of *Perilimnastes*.

***Perilimnastes brookei* (M.P.Nayar) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335505-1

Phyllagathis brookei M.P.Nayar, J. Jap. Bot. 51(8): 232. 1976 (Basionym). Type: Malaysia. Sarawak: Bilengki, Bakelalan, 16 Aug 1955, W.M.A Brooke 10416 (holotype: BM! [BM000019481]).

***Perilimnastes deltoidea* (C.Chen) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335506-1

Phyllagathis deltoidea C.Chen, Bull. Bot. Res., Harbin 4(3): 48. 1984 [“deltoda”] (Basionym). Type: China. Guangxi: Ningming, Mingjiang, Aidian, Gongmushan, 4,000 feet elev., 16 Dec 1935, H.H.Soo 68119 (holotype: IBSC! [IBSC0003993]; isotypes: IBK! [IBK00190675, IBK00190676]).

***Perilimnastes dispar* (Cogn.) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335507-1

Anerinckleistus dispar Cogn. ex Boerl., Handl. Fl. Ned. Ind. (Boerlage) i. 2: 531. 1890; et in DC. Monog. Phan. vii: 479. 1891 (Basionym). Type: Malaysia. Sarawak: O.Beccari 2400 (holotype: FI; isotypes: K! [K000867722], P! [P02274765]).

Phyllagathis dispar (Cogn.) C.Hansen, Nordic J. Bot. 2(6): 559. 1983.

Phyllagathis uniflora Stapf, Hooker's Icon. Pl. 23: t. 2280. 1894. Type: Malaysia. Sabah: Kinabalu, 1892, G.D.Haviland 1172 (holotype: K! [K000867723]; isotypes: K! [K000867724], SAR, SING).

Phyllagathis uniflora var. *longiloba* M.P.Nayar, J. Jap. Bot. 51(8): 233. 1976. Type: Malaysia. Sabah: Kinabalu, Ulu Langanani, Sungei Mamut, 4,500 feet elev., 8 Aug 1961 W.L.Chew, E.J.H.Corner, and A.Stainton 1262 (holotype: K! [K000867721]; isotypes: L, SAR, SING).

***Perilimnastes elegans* (Hai L.Chen, Yan Liu & Ying Liu) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335508-1

Phyllagathis elegans Hai L.Chen, Yan Liu & Ying Liu, Phytotaxa 509(2): 225. 2021 (Basionym). Type: China. Guangxi: Dongxing County, Ma-lu Town, Ping-feng Village, Yuan-ling, Shi-men Valley, on rocks and along grassy streamside in forests, 400–450 m elev., 9 Sept 2020, H.L.Chen, S.Y.Nong, and J.Q.Huang JHC343 (holotype: IBK!; isotypes: A!, IBSC!, PE!)

***Perilimnastes elliptica* (Stapf) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335509-1

Phyllagathis elliptica Stapf, Hooker's Icon. Pl. 23: t. 2279. 1894 (Basionym). Type: Malaysia. Sabah: Kinabalu, G.D.Haviland 1286 (lectotype, designated by Cellinese [2003]: K! [K000867720]).

***Perilimnastes fruticosa* (Ridl.) Ridl., J. Straits Branch Roy. Asiat. Soc. 79: 70, in obs. 1918; Ridley, Fl. Mal. Penins. 1: 773. 1922.**

Anerinckleistus fruticosus Ridl., J. Linn. Soc., Bot. xxxviii. 309. 1908 (Basionym). Type: Malaysia. Pahang: Gunong Tahan, 2 Jul 1905, L.Wray and H.C.Robinson 5453 (lectotype, designated here: BM! [BM000565932]; isoelectotypes: K! [K000867593, K000867594], CAL).

Phyllagathis fruticosa (Ridl.) C.Hansen ex Cellin., Blumea 47(3): 473. 2002.

Notes. When publishing *A. fruticosus*, Ridley (1908) designated L.Wray and H.C.Robinson 5453 as the type without citing a particular herbarium, only stating that the whole collection made by Robinson's expedition should be

sent to the British Museum (BM). Nayar revised *Perilimnastes* in 1974 and noted the specimen in BM as holotype of this species. This was probably only a speculation rather than deliberate lectotypification. In the revision of *Phyllagathis*, Cellinese (2002) chose a duplicate sheet in K as the lectotype, but did not include the phrase “designated here” in the typification statement, as required by Art. 7.11 of the Code (Turland et al. 2018). The specimen sheet in BM [BM000565932] is here designated as the lectotype to eliminate any uncertainty.

***Perilimnastes guillauminii* (H.L.Li) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335510-1

Phyllagathis guillauminii H.L.Li, J. Arnold Arbor. 25: 29, in obs. 1944 (Basionym).

Type: Cochinchine. Bien Hoa, Bao Chiang, L.Pierre s.n. (lectotype, designated by Hansen [1992]: P! [P05200250], drawing, C! [C10014976]). Additional syn-type: Vietnam. Annam: Hue, s.n. (P! [P05200249]).

Phyllagathis hirsuta Guillaumin, Notul. Syst. (Paris) 2: 325, 1913, non Cogn. (1894).

***Perilimnastes melastomatoides* (Merr. & Chun) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335511-1

Osbeckia melastomatoides Merr. & Chun, Sunyatsenia 2: 293. 1935 (Basionym).

Type: China. Hainan: Mo San Leng, 21 Nov 1932, N.K.Chun and C.L.Tso 44310 (lectotype, designated by Li [1944]: A! [A00055333]; isolectotypes: NY! [NY00229583], US! [US00120468]).

Phyllagathis melastomatoides (Merr. & Chun) W.C.Ko, Acta Phytotax. Sin. 8(3): 267. 1963.

***Perilimnastes melastomatoides* var. *brevipes* (W.C.Ko) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335512-1

Phyllagathis melastomatoides var. *brevipes* W.C.Ko, Acta Phytotax. Sin. 8(3): 268.

1963 (Basionym). Type: China. Hainan: Ya Hsien, Yulinwan, 15 Nov 1933, C.Wang 35035 (holotype: HC; isotypes: IBK! [IBK00129997], IBSC! [IBSC0246912, IBSC0003951], NY! [NY00079855]).

***Perilimnastes multisepala* J.H.Dai, T.V.Do & Ying Liu, PhytoKeys 235: 4. 2023.**

Type. VIETNAM. Quảng Nam Province: Đại Lộc, about 400 m south of Khu Du Lịch Sinh Thái Khe Lim, along newly opened road, 574 m elevation, on rocks along a stream, 23 Nov 2019, Jin-hong Dai and Ying Liu 821 (holotype: PE; isotypes: A, SYS, VNMN).

***Perilimnastes ovalifolia* (H.L.Li) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335513-1

Phyllagathis ovalifolia H.L.Li, J. Arnold Arbor. 25: 31. 1944 (Basionym). Type: China. Yunnan: Ping-pien Hsien, 1,400 m, 7 Aug 1934, Tsai 61456 (holotype: A! [A00055329]; isotypes: PE! [PE00781713, PE00781714]).

Phyllagathis calisaurea C.Chen, Bull. Bot. Res., Harbin 4(3): 45. 1984. Type: China. Guangxi: Jingxi, Nanpo, Diding, 20 Jun 1978, T. Fang and X. H. Lu 23672 (holotype: GXMI! [GXMI050227]; isotype: GXMI! [GXMI050228]).

Phyllagathis ovalifolia var. *pauciflora* R.H.Miao, Acta Sci. Nat. Univ. Sunyatseni 32(4): 61. 1993. Type: China. Yunnan: Maguan County, Z.R.Xu and B.Li GL86-7974 (holotype: SYS! [SYS00103897]).

Notes. *Phyllagathis calisaurea* was described, based on specimens collected in western Guangxi, China (Chen 1984b). Subsequent authors did not recognise it as a distinct species and synonymised it within *P. ovalifolia* (Hansen 1992; Chen and Renner 2007). *Phyllagathis calisaurea* and *P. ovalifolia* have adjacent distribution ranges (Guangxi vs. Yunnan, China). They are morphologically quite similar, with the only differences being leaf size (6.5–11.5 × 2–3.7 cm vs. 9–18 × 3–8.5 cm), leaf shape (ovate lanceolate vs. ovate to elliptic) and indumentum of the stems and leaves. Nonetheless, they failed to form a monophyletic group in both the previous (Zhou et al. 2022) and current phylogenetic analyses (Fig. 1). As only one accession of *P. ovalifolia* was included in these analyses, the boundary between *P. ovalifolia* and *P. calisaurea* needs to be further investigated using multiple accessions from across the distribution range. For the time being, we adhere to the species delimitation proposed by Hansen (1992) and Chen and Renner (2007).

***Perilimnastes rupicola* M.P.Nayar, J. Bombay Nat. Hist. Soc. 71(1): 173. 1974.**

Anerincleistus rupicola (M.P.Nayar) J.F.Maxwell, Gard. Bull. Singapore 35(2): 215. 1983.

Phyllagathis rupicola (M.P.Nayar) C.Hansen ex Cellin., Blumea 48(1): 92. 2003.

Type. MALAYSIA. Sarawak: Mt Dulit, Ulu Koyan, alt. 800 m, 16 Sept 1932, S.Synge 503 (holotype: K! [K000867704]).

***Perilimnastes sessilifolia* (C.Hansen) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335514-1

Phyllagathis sessilifolia C.Hansen, Bull. Mus. Natl. Hist. Nat., B, Adansonia Sér. 4, 12(1): 39. 1990 (Basionym). Type: Indochine. Annam: Nui Bach Ma station d'altitude de Huê, 6 Sept 1938, E.Poilane 27614 (holotype: P! [P02274752]; isotypes: P! [P02274753, P02274754]).

***Perilimnastes setipetiola* J.H.Dai, T.V.Do & Ying Liu, PhytoKeys 235: 5. 2023.**

Type. VIETNAM. Lâm Đồng Province: Đà Lạt, Bidoup Nui Ba National Park, 1,500–1,700 m elevation, at damp places under forest, 29 Nov 2019, Jin-hong Dai and Ying Liu 836 (holotype: PE; isotypes: A, SYS, VNMN).

***Perilimnastes setotheca* (H.L.Li) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335515-1

Phyllagathis setotheca H.L.Li, J. Arnold Arbor. 25: 32. 1944 (Basionym). Type: China. Guangxi: Shih Wan Tai Shan, 21 Jul 1937, H.Y.Liang 69817 (holotype: A! [A00055328]; isotypes: IBK! [IBK00127588], IBSC! [IBSC0003958], PE! [PE00781748]).

***Perilimnastes setotheca* var. *setotuba* (C.Chen) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335516-1

Phyllagathis setotheca var. *setotuba* C.Chen, Bull. Bot. Res., Harbin 4(3): 44. 1984 (Basionym). Type: China. Guangdong: Yangjiang, Longgaoshan, 29 May 1956, Wang 41508 (holotype: IBSC! [IBSC0003999]; isotype: IBK! [IBK00127590]).

***Perilimnastes stenophylla* (Merr. & Chun) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335517-1

Bredia stenophylla Merr. & Chun, Sunyatsenia 5: 146. 1940 (Basionym). Type: China. Hainan: Yaichow, 11 Aug 1933, Liang 62530 (lectotype, designated by Li [1944]: A! [A00055335]; isolectotypes: E! [E00090770], G! [G00353917], NY! [ny00221474]).

Phyllagathis stenophylla (Merr. & Chun) H.L.Li, J. Arnold Arbor. 25: 32. 1944.

***Perilimnastes suberalata* (C.Hansen) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335518-1

Phyllagathis suberalata C.Hansen, Bull. Mus. Natl. Hist. Nat., B, Adansonia Sér. 4, 12(1): 39. 1990 (Basionym). Type: Indochine. Annam: Nui Bach Ma station près de Huê Grande Cascade, 16 Apr 1939, E.Poilane 29758 (holotype: P! [P02274749]; isotypes: P! [P02274750, P02274751]).

***Perilimnastes ternata* (C.Chen) Ying Liu, comb. nov.**

urn:lsid:ipni.org:names:77335519-1

Phyllagathis ternata C.Chen, Bull. Bot. Res., Harbin 4(3): 49. 1984 (Basionym). Type: China. Guangdong: Xinyi, Dadufoshan, stream side, 10 Aug 1931, S.P.Ko 51772 (holotype: IBSC! [IBSC0004000]; isotype: IBSC! [IBSC0223824]).

Phyllagathis xinyi Z.J.Feng, J. South China Agr. Univ. 15(4): 75. 1994. Type: China. Guangdong: Xinyi, Dawuling, infra silvis, Z.J.Feng 53621 (holotype: CANT).

***Perilimnastes uniflora* J.H.Dai, T.V.Do & Ying Liu, PhytoKeys 235: 11. 2023.**

Type. VIETNAM. Đà Nẵng: Hòa Ninh, Ba Na Hills, 1,360 m elevation, in forests on damp rocks along stream, 22 Nov 2019, Jin-hong Dai and Ying Liu 814 (holotype: PE; isotypes: A, SYS, VNMN).

***Perilimnastes nana* C.Y.Zou & Ying Liu, sp. nov.**

urn:lsid:ipni.org:names:77335520-1

Figs 6, 7

Type. CHINA. Guangdong Province: Taishan County, Chixi Town, near Zhuxing Village, 200–300 m elevation, amongst rocks along a stream in forests, 15 Jun 2022, Chun-yu Zou 3608 (holotype: IBK; isotypes: IBK, PE).

Diagnosis. Resembles *P. stenophylla* in leaf morphology, but differs in height (to 0.15 m vs. 0.8 m tall), number of flowers per inflorescence (1 vs. 2–3-flowered), length of the peduncle (10–22 mm vs. 4 mm) and the shape of calyx lobes (broadly obovate vs. narrowly triangular). Resembles *P. setotheca* in having 4-sided branchlets, large and persistent bracts below flower and stamen morphology, but differs in plant size (to 0.15 m vs. 1 m tall), leaf shape and size (oblong-lanceolate or obovate-lanceolate, 1.7–7 × 0.73–2.2 cm vs. oblong-lanceolate, elliptic or obovate, 10–20 × 3–8 cm) and number of flowers per inflorescence (1-flowered vs. 3 to more than 20-flowered).

Description. Dwarf shrubs, much-branched, ascending, to 0.15 m tall, with druses in many parts. Stems and leaves sparsely puberulent with minute brown hairs (with few-celled stalk and a glandular head) when young, glabrous when mature. Stems obtusely 4-sided; branchlets 4-sided, with four ribs and two additional ridges extending from the base of the leaf petioles. Leaves opposite, equal to subequal in a pair, glabrous when mature; petiole 2–22 mm; leaf blade oblong-lanceolate or obovate-lanceolate, 1.7–7 × 0.73–2.2 cm, thick papery, 3-veined, green to dark green adaxially, pale green abaxially, base cuneate, apex acute, margin basally entire and remotely denticulate to repand above the base or the middle. Inflorescences terminal, peduncles 1–2.2 cm long; flower solitary, subtended by one or two pairs of leaf-like bracts, bracts 1–1.8 × 0.7–0.9 cm, persistent in fruit. Flowers 4-merous; pedicel 4-sided, ca. 4 mm long in flower and 4–10 mm in fruit; hypanthia funnel-shaped, glabrous, ca. 7 × 6 mm; calyx lobes 4, broadly obovate, glabrous, 4–5 × 5 mm; petals pinkish-purple, ca. 15 × 7 mm, obovate, oblique, apex acute or short acuminate, glabrous on both sides; stamens 8, isomorphic, filaments 8–10 mm long, white or pink, glabrous, anthers ovate-lanceolate, curved to ventral side, pinkish-purple with yellow base, ca. 9 mm long, connective dorsally forming a 0.7–1 mm long spur and ventrally forming two yellow ridges; ovary ca. 3 mm long, half as long as hypanthium (crown excluded), ovary crown wedge-like, 4-lobed; styles 20 mm long. Old (post-mature) capsules cup-shaped, 7–9 × 4–7 mm, 4-sided; hypanthium 8-ribbed; crown enlarged and enclosing an obpyramidal space; placental column unbeaked, 4-horned; placenta thready.



Figure 6. Holotype of *Perilimnastes nana*, Chun-yu Zou 3608 (IBK). The insets show details of leaf surface under stereo-scope, branchlet and flower. Scale bars: 10 cm, 1 mm (upper right inset); 3 mm (lower insets).

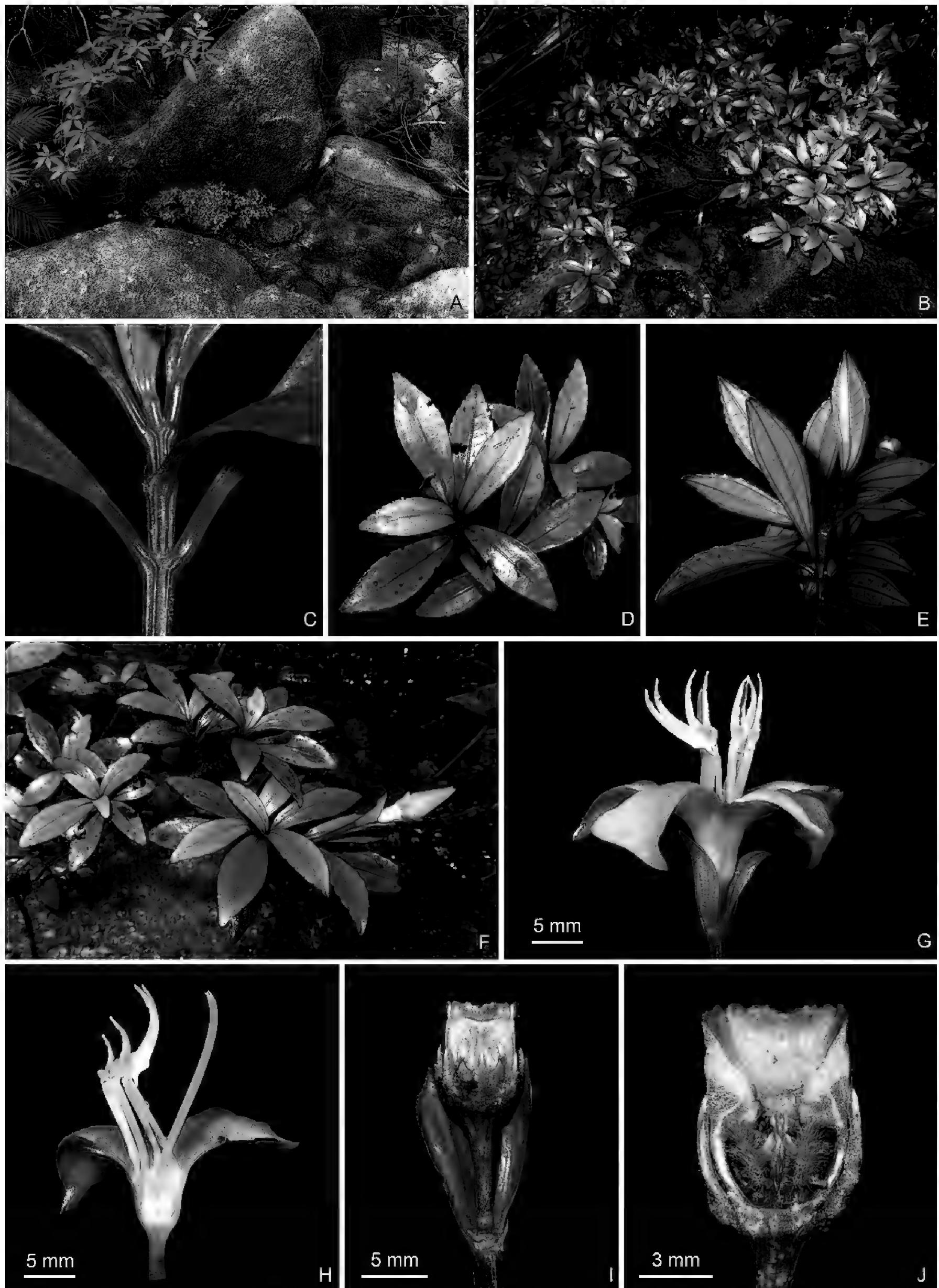


Figure 7. *Perilimnastes nana* **A** habitat **B** habit **C** close-up of a branchlet **D** adaxial leaf surfaces **E** abaxial leaf surfaces **F** a flowering branch showing an inflorescence with a single flower and two large bracts **G** lateral view of a flower **H** longitudinal section of a flower showing stamen morphology **I** lateral view of an old capsule with one persistent bract removed **J** longitudinal section of an old capsule showing enlarged ovary crown and morphology of the placental column and placentas. Scale bars: 5 mm (**G–I**); 3 mm (**J**). All from Chun-yu Zou 3608 (IBK, PE).

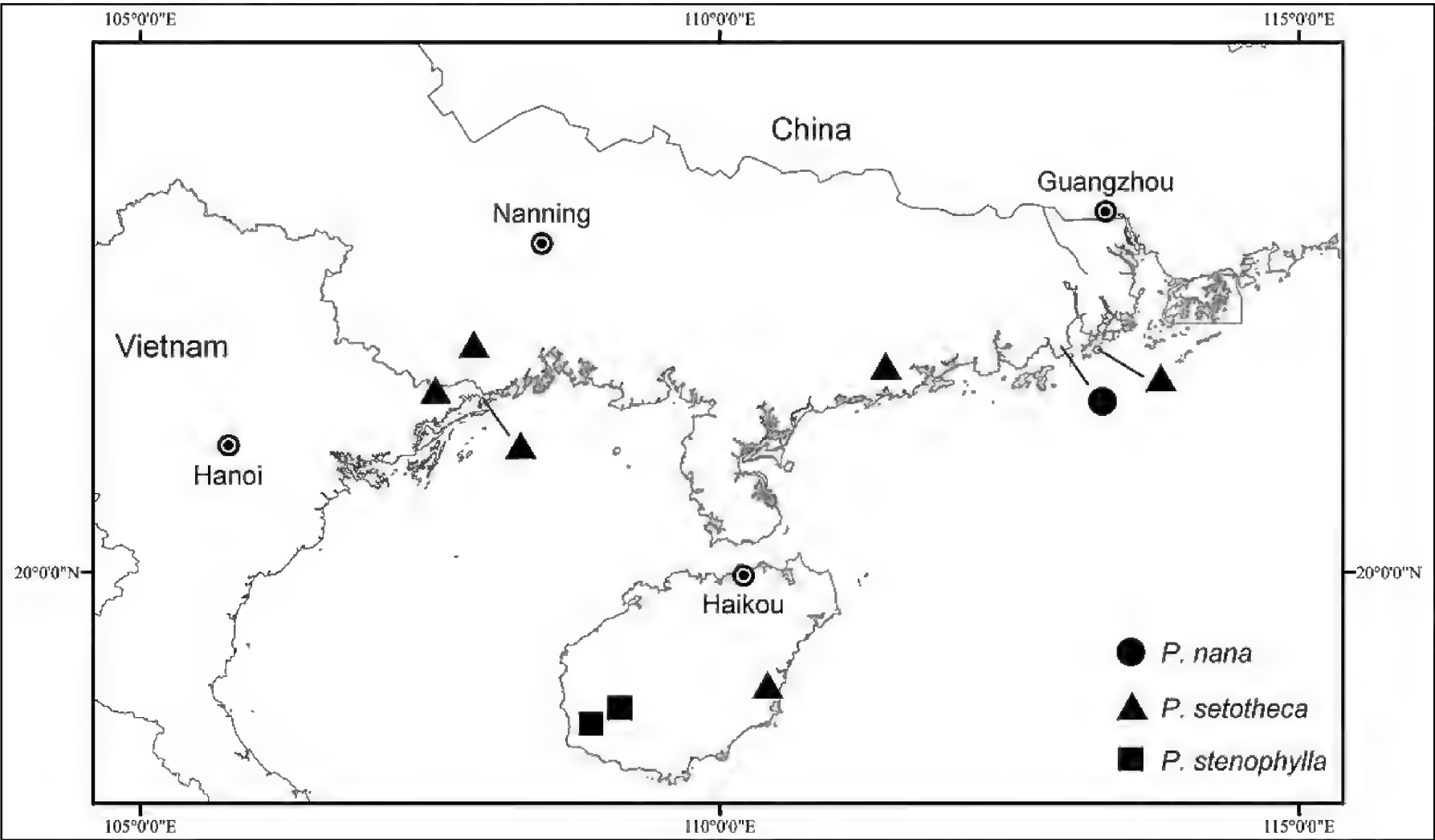


Figure 8. Distribution of *Perilimnastes nana* (solid circle), *P. setotheca* (triangle) and *P. stenophylla* (square).

Phenology. Flowers in May and June, old capsules in October.

Etymology. The specific epithet is based on the habit of this species, viz. dwarf shrubs to 15 cm tall.

Distribution. *Perilimnastes nana* is currently known from Taishan County, Guangdong Province, China (Fig. 8). It grows amongst rocks along streams in the forest, at 200–300 m elevation.

Notes. During a survey of herbarium specimens of *Phyllagathis* in IBSC, a collection (Ze-xian Li et al. 516) from Taishan, Guangdong, China caught our attention. This plant (*P. nana*) closely resembles *P. stenophylla* from Hainan Island in the oblong-lanceolate leaf blades and was misidentified as the latter species. Closer inspection reveals that it has strictly 1-flowered inflorescences and broadly obovate calyx lobes, which distinguishes it from *P. stenophylla*. Field trips in 2022 and 2023 revealed other differences between the two species, such as plant size and peduncle length. *Perilimnastes nana* is phylogenetically closest to *P. setotheca*, a species found in Guangdong, Guangxi and Hainan China (Fig. 8). However, they differ markedly in plant size, leaf shape and size and number of flowers per inflorescence. As a result, *P. nana* is quite distinct from its closest relatives, prompting us to describe it as a new species.

Additional specimen examined. CHINA. Guangdong Province: Taishan County, Chixi Town, Zhuxing Village, 220 m elevation, 17 Oct 2023, Ying Liu 892 (SYS); Taishan County, Chixi Town, Liugushan, 8 May 1981, Ze-xian Li et al. 516 [IBSC (IBSC0223903)].

Key to the species of *Perilimnastes*

- 1 Raphides present, appearing on leaf surfaces as whitish oblong spots when dried.....2
- Raphides absent13

- 2 Flowers always solitary.....3
 - Flowers often in few-flowered umbels, sometimes or rarely reduced to a solitary flower, rarely many-flowered.....4
- 3 With sparse minute brown glands on branchlets and leaves when young, glabrescent; leaf blade obovate to obovate-lanceolate, base cuneate to narrowly cuneate..... ***P. uniflora***
 - With uniseriate, pale brown hyaline hairs on branchlets and leaves; leaf blade elliptic, base acute to rounded***P. dispar***
- 4 Leaf blades broadly obovate to suborbicular, 2.5–3.5 cm long***P. brookei***
 - Leaf blades ovate, elliptic, narrowly elliptic, or elliptic-lanceolate, often > 4 cm long5
- 5 Inflorescence sessile or nearly sessile6
 - Inflorescence with 1–3.5 cm long peduncles.....10
- 6 Leaf blades narrowly elliptic7
 - Leaf blades broadly elliptic or elliptic.....8
- 7 Hypanthia with sparse minute brown glands; anthers yellow.....***P. rupicola***
 - Hypanthia with sparse minute brown glands and dense patent brown bristles; anthers purplish***P. guillauminii***
- 8 Petioles densely villous with appressed, brown hyaline hairs, without bristles ***P. banaensis***
 - Petioles with bristles9
- 9 Mature stem with curly retrorse bristles; leaf bases rounded to broadly rounded; anthers yellowish ***P. elliptica***
 - Mature stem glabrescent; leaf bases cuneate; anthers pinkish.....***P. setipetiola***
- 10 Stems hirsute with crooked, multiseriate hairs11
 - Stems hirsute with straight, multiseriate hairs12
- 11 Leaf blade oblanceolate to elliptic-lanceolate, 4.8–14 × 1.1–2.7 cm; peduncle pubescent with minute, appressed hairs ***P. elegans***
 - Leaf blade elliptic to long elliptic, 5–13 × 1.5–4 cm; peduncle pubescent with spreading hairs***P. deltoidea***
- 12 Stems retrorse hirsute with multiseriate hairs or pubescent with hyaline uniseriate hairs; leaf blade 7–18 × (2–)3–8.5 cm.....***P. ovalifolia***
 - Stems densely setose with multiseriate hairs; leaf blade 5–8 × 2.5–4 cm...
..... ***P. ternata***
- 13 Leaf base broadly cordate ***P. sessilifolia***
 - Leaf base broadly cuneate, cuneate, or acuminate.....14
- 14 Mature stems and leaves with appressed or ascending bristles.....
..... ***P. melastomatoides***
 - Mature stems and leaves glabrous15
- 15 Leaves unequal, rarely subequal, in a pair***P. suberalata***
 - Leaves usually equal or subequal in a pair16
- 16 Leaf blades 10–20 × 3–8 cm; inflorescences subtended by an involucre of several bracts (often 4)***P. setotheca***
 - Leaf blades 2.8–10(–14) × 0.6–2.4(–4.2) cm; inflorescences subtended by a pair of small leaves/bracts17
- 17 Calyx lobes 4–8***P. multisepala***
 - Calyx lobes 4.....18
- 18 Dwarf shrubs to 15 cm tall; inflorescence 1-flowered..... ***P. nana***
 - Shrubs to 80–100 cm tall; inflorescence 1–4-flowered.....19

- 19 Calyx lobes ca. 3 mm long, not keeled; anthers purplish.....*P. stenophylla*
– Calyx lobes 4–7 mm long, keeled; anthers yellow *P. fruticosa*

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Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Supplementary material 1

Source of materials studied

Authors: Ying Liu, Jin-Hong Dai, Qi-Yuan Zhuang, Chun-Yu Zou, Kai-Nan Ma

Data type: xlsx

Explanation note: The name of the new species is indicated in bold.

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